RECOVERY PLAN

Waccamaw Silverside

(Menidia extensa)

U.S. Fish and Wildlife Service

RECOVERY PLAN

for

Waccamaw silverside (*Menidia extensa*)

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Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect the species. Plans are prepared by the U.S. Fish and Wildlife Service, sometimes with the assistance of recovery teams, contractors, State agencies, and others. Objectives will only be attained and funds expended contingent upon appropriations, priorities, and other budgetary constraints. Recovery plans do not necessarily represent the views nor the official positions or approvals of any individuals or agencies, other than the U.S. Fish and Wildlife Service, involved in the plan formulation. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1993. Waccamaw Silverside Recovery Plan. Atlanta, GA. 24 pp.

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Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
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EXECUTIVE SUMMARY

Current Status: This North Carolina endemic is listed as threatened. The species presently occurs only in Lake Waccamaw, and occasionally in the upper Waccamaw River directly below the lake, in Columbus County, North Carolina. The historic range of the Waccamaw silverside is the same as its present range. Lake Waccamaw, in its entirety, to the mean high-water level, and Big Creek, from its mouth at Lake Waccamaw upstream approximately 0.6 kilometer (0.4 mile) to the County Road 1947 bridge crossing, is designated as critical habitat for the species.

Habitat Requirements and Limiting Factors: The Waccamaw silverside is a lacustrine species. It is gregarious and is usually found in schools near the surface. It forages in areas of shallow, open water over a clean, dark sand substrate with no vegetation and spawns in open-water areas near the shoreline. Water quality and habitat deterioration/alteration (caused by increasing siltation, nutrient or pollutant loading, or by altering water temperature or pH) and the introduction/invasion of nonnative species are the most significant threats to the species' continued existence. The species has a 1-year life cycle and depends upon successful reproduction each year for its survival. It is, therefore, subject to sudden extinction should its habitat deteriorate, even for a short term, to the point where a single year's reproduction fails or is significantly reduced.

Recovery Objective: Maintain a self-sustaining population of the Waccamaw silverside in Lake Waccamaw and protect its habitat from present and foreseeable threats. Based on available information concerning the range, biology, and threats to its continued survival, delisting of the Waccamaw silverside does not appear to be feasible.

Recovery Criteria: The species' biology and restricted distribution make it unlikely that the Waccamaw silverside can be sufficiently protected from all threats associated with potential degradation and alteration of the water and/or habitat quality of Lake Waccamaw to allow the species to be delisted. However, as additional data on the species and threats to its continued existence are obtained, the potential for developing recovery criteria will be reevaluated.

Actions Needed:

1. Protect the existing population and essential habitat.
2. Elicit support through development and utilization of an information/education program.
3. Determine the specific habitat requirements of all life stages of the species and threats to the species' continued existence.
4. Implement management and, to the extent possible, alleviate threats to the species' existence.
5. Develop techniques for artificial holding/propagation and cryopreservation of the species.
6. Implement a bi-annual monitoring program to assess the status of the species and the water and habitat quality of Lake Waccamaw.

Cost ($000's):

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Need 6	Total
1993	5.5	8.0	15.0	0.0	30.0	5.0	63.5
1994	5.5	5.5	15.0	20.0	15.0	5.0	66.0
1995	5.5	3.0	15.0	20.0	5.0	5.0	53.5
1996	5.5	0.0	0.0	20.0	5.0	5.0	35.5
1997	5.5	0.0	0.0	?	5.0	5.0	15.5*
1998	5.5	3.0	0.0	?	5.0	5.0	18.5*
1999	5.5	0.0	0.0	?	5.0	5.0	15.5*
2000	5.5	0.0	0.0	?	5.0	5.0	15.5*
2001	5.5	3.0	0.0	?	5.0	5.0	18.5*
2002	5.5	0.0	0.0	?	5.0	5.0	15.5*
2003	5.5	0.0	0.0	?	5.0	5.0	15.5*
Total:	60.5	22.5	45.0	60.0*	90.0	55.0	333.0*

*Habitat improvement costs needed for the species' management will not be known until the magnitude of specific threats is determined through research.

Date of Recovery: Total recovery is unlikely for this species.

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PART I

INTRODUCTION

On April 8, 1987 (52 FR 11277), the U. S. Fish and Wildlife Service (1987) listed the Waccamaw silverside (*Menidia extensa*) as a threatened species. Lake Waccamaw in Columbus County, North Carolina, was designated in its entirety, to the mean high-water level, and Big Creek, from its mouth at Lake Waccamaw upstream approximately 0.6 kilometer (0.4 mile) to the County Road 1947 bridge crossing, as critical habitat for the species. This lacustrine species has been recorded only from Lake Waccamaw and the upper Waccamaw River directly below the lake. Its continued existence is dependent primarily upon maintaining the water and habitat quality of Lake Waccamaw.

Description, Ecology, and Life History

The Waccamaw silverside (*Menidia extensa*), a freshwater derivative of *M. beryllina* stock (Lee et al. 1980, Lindquist 1981), was described by Hubbs and Raney (1946). This species, sometimes referred to as the "skipjack" or "glass minnow" (Davis and Louder 1969), is a long, slender, almost transparent fish with a silvery stripe along each side. There is no sexual dimorphism. Adults are about 6.5 centimeters (2.5 inches) long. The body is laterally compressed, the eyes and mouth are large, and the jaw is sharply angled upward. The scales are very small and tissue-paper thin (Hubbs and Raney 1946). There are two dorsal fins, widely separated and transparent, supported by flexible spines (Hubbs and Raney 1946, Cooper et al. 1977).

The Waccamaw silverside is a lacustrine species. It is gregarious and is usually found in schools near the surface (Davis and Louder 1969). It inhabits areas of shallow, open water over a clean, dark sand substrate with no vegetation (Davis and Louder 1969, Lee et al. 1980, Shute et al. 1981). During periods of increased wave action and turbidity, the species is usually found in open-water areas near the shore, and on calm days it is usually found 100 to 200 feet from the shoreline (Davis and Louder 1969). The Waccamaw silverside is possibly the most abundant fish species in the lake (Shute et al. 1981) and probably serves as a major food item for the larger predator fishes of the lake (Davis and Louder 1969).

Spawning behavior of the Waccamaw silverside was studied by Davis and Louder (1969). Although spawning has not been observed, the species spawns after its first winter (at approximately 1 year of age). No external characteristics indicate spawning condition, other than the more robust form of the ripe female during the pre-spawning period. Developing eggs have been found in females of the species as early as November. Spawning occurs from March through July, with the peak of spawning occurring when water temperatures are between 68 and 72 degrees Fahrenheit, usually in late March and early April. The number of eggs spawned per female averages approximately 150.

Spawning takes place in open water near the shoreline and does not appear to be associated with aquatic vegetation. There is no parental care of the eggs or young, and apparently almost all adults die soon after spawning. Only a very small percentage of the population reaches 2 years of age. The earliest hatching occurs around the end of April or the first of May, and the larvae gather in isolated schools of approximately 100 fish.

The mouth of the Waccamaw silverside is large and terminal, characteristic of carnivorous fishes. The species is believed to feed almost exclusively on zooplankton (Davis and Louder 1969). It apparently feeds throughout the day and night, with no preference for time, and utilizes the most available zooplankton present. Stomach content analysis showed a preponderance of crustaceans, primarily Ostracoda and Cladocera (Davis and Louder 1969). Aquatic insects appear to be only a minor percentage of the prey consumed. No plant material was found in any of the stomachs analyzed. Evidence indicates the species is a surface, open-water feeder (Davis and Louder 1969).

Distribution and Threats to Its Continued Existence

The Waccamaw silverside is endemic only to Lake Waccamaw and the upper Waccamaw River in Columbus County, North Carolina. The species has never been taken from outside the lake, or from the man-made canals surrounding the lake, with the exception of the Waccamaw River immediately below the Lake Waccamaw Dam (Shute et al. 1981, Lindquist and Yarbrough 1982). Specimens have not been reported in the river from more than 30 to 40 meters (m) downstream of the lake, and those individuals collected below the dam are believed to be "washovers" from the lake during periods of high water (Shute et al. 1981, Lindquist and Yarbrough 1982).

Lake Waccamaw is considered unique among Atlantic coastal lakes and is a registered North Carolina Natural Heritage Area. The lake and its drainage have a diverse fish fauna (56 to 62 species), including many popular game fish and a number of endemics and forms that occur in only one other drainage (Shute et al. 1981). Teuling and Cooper (1977) listed 17 species of plants and animals from in and around the lake that were considered of special concern to biologists. Lake Waccamaw has a surface area of approximately 3,618 hectares (8,934 acres). The average depth of the lake is 2.3 m (7.5 feet), with a maximum depth of 3.3 m (10.8 feet). The waters of the lake are exceptionally clear, and water temperatures vary less than 2 degrees from the surface to the bottom throughout the year. The pH of Lake Waccamaw is virtually neutral (Davis and Louder 1969, Porter 1985), although the lake is fed by four acidic, swampy streams--Big, Little, Second, and Third Creeks. This near neutral condition, unusual among North Carolina's coastal plain lakes, is believed to be caused, at least in part, by the buffering effect of the limestone formation underlying the lake (Frey 1951, Shute et al. 1981, Cahoon et al. 1990). The substrate of the lake bottom is composed mainly of

clean sand and fibrous peat underlain by a calcareous Waccamaw limestone formation that is exposed along the north shore (Frey 1951, Shute et al. 1981). The most common species of aquatic vegetation in the lake includes dense beds of maidencane (*Panicum hemitomum*), Cape Fear spatterdock (*Nuphar luteum sagitifollium*), and bushy-pondweed (*Najas guadalupensis*). A green alga (*Nitella* sp.) is seasonally abundant (Shute et al. 1981). Approximately 70 percent of the lake's shoreline has been residentially developed, while the remainder is undeveloped wooded swamp. Part of the undeveloped portion of the shoreline includes Lake Waccamaw State Park, which is located along the southeastern shore.

Potential degradation of the water quality of Lake Waccamaw - the only known habitat of the Waccamaw silverside - is the most significant threat to the species' continued survival. Because the Waccamaw silverside has a 1-year life cycle, it is subject to sudden extinction should its habitat deteriorate, even for a short term, to the point where a single year's reproduction fails or is significantly reduced. Human-related activities that could prove detrimental to the water quality of the lake (by causing or increasing siltation, nutrient, or pollutant loading or by altering water levels, temperature, or pH) include, but are not limited to, increased development, indiscriminate logging, increased farming activities and other land use changes, stream alteration (such as channelization or impoundment), withdrawal of water from the lake or streams feeding the lake, road and bridge construction, runoff of pesticides and fertilizers, leachate from septic systems, and other point and nonpoint pollution discharge.

The discharge, runoff, or leaching of contaminants (i.e., insecticides, herbicides, fungicides, heavy metals, or other contaminants) into the lake or its tributaries could result in direct or secondary poisoning of the Waccamaw silverside or could seriously affect the food resources of the species. A primary portion of the silverside's diet includes cladoceran and ostracod organisms. These invertebrate groups are often the most sensitive to the toxic effects of pesticides (Douglas Urban, Environmental Protection Agency, personal communication, 1992) and other contaminants.

Casterlin et al. (1986) characterized the lake as being incipiently eutrophic (due to high levels of phosphorous loading) and in danger of reaching a hypereutrophic state characterized by massive algal blooms if continued increases in nutrient loading occur. However, the North Carolina Department of Environmental Management (NCDEM) currently considers Lake Waccamaw to have excellent water quality and rates the lake's trophic level as mesotrophic (Jimmie Overton, NCDEM, personal communication, 1992). Studies conducted by Cahoon et al. (1990) indicate that Lake Waccamaw has been mesotrophic to borderline eutrophic throughout its history. This trophic condition is believed to be supported by the natural input of phosphorus from the weathering of the limestone formation underlying the lake (Cahoon et al. 1990), and the input of nutrients from anthropogenic sources

does not currently appear to be a problem. However, the lake's shallow, clear waters and natural productivity (due to relatively high phosphate content from internal sources) would suggest that the lake is vulnerable to eutrophication if nutrient loading from external sources should occur or increase. Also, because the primary source of nutrient input into the lake appears to be internal, any factor(s) increasing water retention time within the lake could have the same effect on the water quality as increased nutrient loading from external sources (Lawrence Cahoon, University of North Carolina at Wilmington, personal communication, 1992).

The introduction or invasion of nonnative species into Lake Waccamaw or its watershed poses another serious threat to the Waccamaw silverside. The State of North Carolina recently issued a permit to propagate hybrid bass at several locations in the Lake Waccamaw watershed. Although the permit stipulates certain protective measures, escape of nonnative predators from such a project, or through some other source, into the system could upset the existing predator prey relationships to the detriment of the Waccamaw silverside and other fishes now present in the lake. Invasion or introduction of nonnative aquatic weeds (e.g., *Hydrilla*) into the lake could eventually result in the elimination of the open-water habitat required by the Waccamaw silverside and require intensive and potentially harmful control measures. Another major concern is the zebra mussel (*Dressena polymorpha*). This exotic freshwater mussel was first discovered in Lake St. Clair in the mid- to late 1980s and has since colonized all five of the Great Lakes and is rapidly expanding into the surrounding river basins, including those of the South Atlantic Slope (O'Neill and MacNeill 1991). Many biologists believe the species may ultimately infest most areas of North America (O'Neill and MacNeill 1991). *Dressena polymorpha* is a prolific breeder and, once established in an area, can reach very high density levels (O'Neill and MacNeill 1991). Like other freshwater mussels, *D. polymorpha* feeds by siphoning phytoplankton, zooplankton, and other food items from the water column. There is concern that the tremendous filtering activity exerted by high-density populations of the species could disrupt the natural food chain and affect entire aquatic communities of infested lakes and streams (Hebert et al. 1991, O'Neill and MacNeill 1991, Weigmann et al 1991.).

PART II

RECOVERY

A. Recovery Objectives

The U. S. Fish and Wildlife Service's goal in developing and implementing recovery plans is to recover a species to the point where Endangered Species Act protection is no longer required. This is often accomplished through the establishment and protection of some specified number of self-sustaining populations throughout a significant portion of the species' historic range. A self-sustaining population is a reproducing population that is large enough to maintain sufficient genetic variation to enable it to survive and respond to natural habitat changes without intensive management. These populations must be sufficiently dispersed, or occur on large enough tracts, to ensure their perpetuation. However, based on available information concerning the range, biology, and threats to its continued survival, recovery of the Waccamaw silverside does not appear to be feasible (unless other populations are discovered or other populations are established in some presently unknown historic habitat). It is unlikely that the Waccamaw silverside can be sufficiently protected from all threats associated with potential degradation or alteration of the water and/or habitat quality of Lake Waccamaw to allow the species to be delisted. However, as additional data on the species and threats to its continued existence are obtained, the potential for developing recovery criteria will be reevaluated.

Accordingly, the objective of this recovery plan is to protect and maintain a self-sustaining population of the Waccamaw silverside in Lake Waccamaw and to protect its habitat from present and foreseeable threats.

B. Narrative Outline

1. Protect the existing population and essential habitat. The Waccamaw silverside occurs only in Lake Waccamaw and, as described, occasionally is found in the upper Waccamaw River in Columbus County, North Carolina. Although there are several other shallow lakes in Columbus County and other eastern North Carolina counties, the Waccamaw silverside has never been found outside of its present range. Because the species has a 1-year life cycle, it depends upon successful reproduction each year for its survival. Any activity, incident, etc., adversely affecting water or habitat quality of the lake, even for brief periods during a given year, could result in the extinction of the Waccamaw silverside. All actions and activities, around the lake and its watershed (especially Big Creek), must be carefully reviewed, planned, and implemented with protection of the Lake Waccamaw ecology in mind. Lack of proper protection and management of this population and the lake will ultimately lead to the species' extinction.

1.1 Utilize existing legislation and regulations (Federal Endangered Species Act, Federal and State water quality regulations, stream alteration regulations, surface mining laws, etc.) to protect the species and its habitats. Degradation of the water quality of Lake Waccamaw appears to be the most significant threat to the survival of the Waccamaw silverside. Complete compliance with Federal and State laws and regulations designed to protect water and habitat quality must be ensured if the species is to survive. Unless this objective is met, any other recovery activities would be futile.

1.2 Work with appropriate Federal and State regulatory and review agencies to identify and assess projects and/or activities that could have negative effects on the species and to ensure incorporation of measures for protecting the species and its habitat into such activities. Through Section 7 of the Endangered Species Act, the Fish and Wildlife Coordination Act, Clean Water Act, etc., Federal and State regulatory and review agencies must work together to carefully evaluate and identify actions and activities with the potential to adversely affect the species and its habitat. Once impacts have been identified, regulatory/permitting agencies must utilize their authorities to ensure that the species and its habitat are adequately protected.

1.3 Solicit help in protecting and enhancing the species and its essential habitat. Assistance and support of

conservation groups, local governments, and regional and local planners will be essential in meeting the goal of maintaining the Waccamaw silverside. Also, support of local industrial, business, and farming communities, as well as local residents, is vital. Construction, forestry, and agricultural "best management practices" must be implemented by all landowners. Local and county land use planning must be designed and implemented to protect Lake Waccamaw and its watershed. Individuals should to be educated regarding the natural processes of the lake, how human activities influence these processes, and measures needed to protect the lake and the Waccamaw silverside. Without a continuing commitment from the local people who have an influence on the water and habitat quality of the lake, any efforts to maintain the Waccamaw silverside will meet with little success.

1.3.1 Meet with local government officials and regional and local planners to inform them and solicit their support for efforts undertaken for protection of the species and its essential habitat.

1.3.2 Meet with local business, farming, logging, and industry interests and elicit their support, and where feasible provide them assistance, in implementing protective actions.

1.3.3 Develop an educational program using such items as slide/tape shows, brochures, etc. Present this material to business groups, civic groups, schools, church organizations, etc. Educational material outlining the goals and emphasizing the benefits of maintaining and upgrading habitat quality will be extremely useful in informing the public of our actions and implementing Tasks 1.3.1 and 1.3.2 above.

1.4 Encourage establishment of outstanding resource water or high-quality water designations, buffer zones, conservation easements, and other protection strategies as a means of protecting the species. The U.S. Fish and Wildlife Service should work with the appropriate State agencies in North Carolina to have special status assigned to the lake and its watershed (especially Big Creek) that would provide increased protection to the Waccamaw silverside.

1.5 Consider the use of land acquisition as a means of protecting the species' essential habitat. Land acquisition (particularly of presently undeveloped

areas within the lake's watershed) could provide long-term protection to the species and should be explored.

2. Determine threats to the species, conduct research necessary for the species' management, and implement management where needed.

2.1 Conduct research on the species and characterize the specific habitat requirements (relevant physical, biological, and chemical components) for all life history stages. Detailed knowledge of the habitat requirements of the species; community structures of associated flora and fauna; and how these biotic and abiotic factors interact and affect reproduction, growth, and mortality rates of the Waccamaw silverside are needed in order to focus management and recovery efforts on specific problems within the species' habitat. Knowledge of the environmental requirements of all life history stages of the species and an understanding of the nature of the habitat occupied by the species is essential to management for the species' long-term survival.

2.2 Identify and eliminate current and future threats to the species' survival. Water/habitat quality deterioration/alteration (caused by increasing siltation, nutrient, or pollutant loading or by altering water retention time, temperature or pH) and the introduction/invasion of nonnative species appear to be the primary threats to the Waccamaw silverside. All potential sources of these threats (and other potential threats) need to be identified and methods and effects of controlling or altering these sources need to be determined. The nature of and mechanisms by which these and other factors impact the species are not entirely understood. The extent to which the species can withstand these impacts is also unknown. To minimize and eliminate these threats, the information gathered in Task 2.1 must be utilized to target and correct specific problem areas and determine the specific causative agent(s).

2.3 Based on the biological data and threat analysis, investigate the need for management, including habitat improvement. Implement management where needed to secure the species. Specific components of the Waccamaw silverside's habitat may be stressed or threatened, and this may limit the species' potential for survival. Habitat improvement programs may be needed to alleviate these threats to the species.

2.4 Determine the number of individuals required to maintain a viable population. Inbreeding depression can be a major obstacle to species recovery, especially if the remaining population sizes are small and/or have gone through some type of genetic bottleneck. The actual number of individuals in a population is not necessarily a good indication of a population's genetic viability; rather, the "effective population" size is needed. The effective population size is the size of an "ideal" population in which genetic drift takes place at the same rate as in the actual population (Chambers 1983). Franklin (1980) suggested that the inbreeding coefficient should be limited to no more than 1 percent per generation, a figure which implies that the short-term, maintenance effective-population-size should be no fewer than 50 individuals (Frankel and Soulé 1981, Franklin 1980, Soulé 1980). Because the effective population size is typically only one-third to one-forth the actual population size (being affected by sex ratio, overlapping generations, generally nonrandom distribution of offspring, and nonrandom mating) (Soulé 1980), a population of 150 to 200 individuals is needed for short-term population maintenance. Soulé (1980) further suggests that for long-term viability, an effective population of 500 individuals is necessary, translating into a population size of 1,500 to 2,000 individuals. Some of these factors can be addressed under Task 2.1, while others will need to be addressed as part of this task.

3. Develop artificial holding and propagation techniques and, if feasible, establish captive populations. There is an immediate need to develop techniques for holding and propagating the Waccamaw silverside to allow for reestablishment or augmentation of the existing population. Under present conditions, with the species occurring only in Lake Waccamaw, we have "all our eggs in one basket." This, coupled with the species' biology, makes the Waccamaw silverside extremely vulnerable to extinction from a single catastrophic event or a combination of events or activities adversely affecting Lake Waccamaw, even for a short period of the year. Because the species is endemic only to Lake Waccamaw, reintroduction into other areas is not appropriate and may not be feasible. Development of artificial holding/propagation techniques and, if feasible, establishment of captive populations would allow for the reestablishment of a population in Lake Waccamaw, if the species were eliminated from the lake, or for population augmentation, if the Lake Waccamaw population were significantly reduced in number to a point where its viability and survival were threatened. The number of individuals necessary to maintain viability will be determined in Task 2.4.

4. Develop and implement cryogenic techniques to preserve the species' genetic material. Past attempts (Davis and Louder 1968) to transport and hold Waccamaw silversides have proved unsuccessful, and development of successful holding/ artificial propagation techniques (Task 3 above) may take a substantial period of time. Also, because of the species' biology, long-term maintenance of captive populations may not be feasible. Cryogenic preservation of the Waccamaw silverside could maintain genetic material (much like seed banks for endangered plants) from the extant population indefinitely. Once artificial holding or propagation techniques are developed, cryopreservation could then allow for the eventual creation and reestablishment of the silverside population in the lake (if necessary), using genetic material preserved from that population without requiring continuous maintenance of a captive population.

5. Develop and implement a program to monitor Waccamaw silverside population levels and water/habitat conditions of Lake Waccamaw. The status of the species and its habitat must be continually monitored to assess their conditions and identify any potential problems. Quantitative samples should be taken to determine silverside population densities and the chemical, physical, and biological quality of the lake. Special emphasis should be placed on evaluation of the nutrient content and growth of aquatic vegetation in the lake. Sedimentation of the lake should also be monitored. This monitoring should be conducted at least on a bi-annual schedule.

6. Annually assess overall success of the recovery program and recommend action (changes in recovery objectives, continue to protect, implement new measures, other studies, etc.). The recovery plan must be evaluated periodically to determine if it is on track and to recommend future actions. As more is learned about the species and as conditions change, recovery objectives may need to be modified.

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PART III

IMPLEMENTATION SCHEDULE

Priorities in column one of the following Implementation Schedule are assigned as follows:

1. Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

2. Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

3. Priority 3 - All other actions necessary to meet the recovery objective.

Key to Acronyms Used in This Implementation Schedule

FWS - U.S. Fish and Wildlife Service
ES - Ecological Services Division of the U.S. Fish and Wildlife Service
LE - Law Enforcement Division of the U.S. Fish and Wildlife Service
COE - U.S. Army Corps of Engineers
EPA - U.S. Environmental Protection Agency
NCDA - North Carolina Department of Agriculture
NCDEM - North Carolina Division of Environmental Management
NCDPR - North Carolina Division of Parks and Recreation
NCWRC - North Carolina Wildlife Resources Commission
SCS - U.S. Soil Conservation Service
TNC - The Nature Conservancy

WACCAMAW SILVERSIDE IMPLEMENTATION SCHEDULE

Priority	Task Number	Task Description	Task Duration	Responsible Agency FWS	Responsible Agency Other	Cost Estimates ($000's) FY1	FY2	FY3	Comments
1	1.1	Utilize existing legislation and regulations to protect species and its habitat.	Continuous	R4/ES and LE	COE, EPA NCDA, NCDEM, NCWRC	2.5	2.5	2.5	
1	1.2	Work with appropriate Federal and State agencies to identify actions that could negatively affect the species and incorporate protective measures into such actions.	Continuous	R4/ES	COE, EPA NCDA, NCDEM, NCDPR, NCWRC, SCS	3.0	3.0	3.0	
1	1.4	Encourage establishment of outstanding resource water designations and other protective strategies as a means of protecting the species.	Ongoing	R4/ES	COE, EPA NCDA, NCDEM, NCDPR, NCWRC, SCS, TNC	???	???	???	
2	1.3.1, 1.3.2	Meet with local government officials and business interests and elicit their support for recovery.	3 years	R4/ES	COE, EPA NCDA, NCDEM, NCDPR, NCWRC, SCS, TNC	3.0	2.0	1.0	
1	1.3.3	Develop information and education program and present.	Ongoing	R4/ES	NCDPR, NCWRC, TNC	5.0	3.5	2.0	Task duration: 1 year to develop, then continuous.
2	1.5	Consider use of land acquisition to protect the species.	Ongoing	R4/ES	NCDPR, NCWRC, TNC	???	???	???	
2	2.1, 2.2	Conduct research necessary for species' protection and management; i.e., habitat requirements, biology, and threat analysis.	3 years	R4/ES	NCWRC	15.0	15.0	15.0	

WACCAMAW SILVERSIDE IMPLEMENTATION SCHEDULE (continued)

Priority	Task Number	Task Description	Task Duration	Responsible Agency FWS	Responsible Agency Other	Cost Estimates ($000's) FY1	FY2	FY3	Comments
See comments.	2.3	Based on biological and threat analysis, investigate need for management and implement where needed.	2 years	R4/ES	COE, EPA NCDA, NCDEM, NCDPR, NCWRC, SCS	---	20.0	20.0	Priority 1, 2, or 3, depending on result of 2.1, 2.2, and 2.3.
2	2.4	Determine number of individuals required to maintain viable population.	1 year	R4/ES	Contract	---	---	???	
2	3	Develop artificial holding and propagation techniques; if feasible, establish captive populations.	Ongoing	R4/ES	Contract	20.0	20.0	3.0	Task duration: 3 years (protection continues).
2	4	Develop and utilize cryopreservation techniques.	Ongoing	R4/ES	Contract	10.0	10.0	2.0	
2	5	Develop and implement a monitoring program.	Ongoing	R4/ES	NCDPR, NCWRC	5.0	5.0	5.0	Biannual.
3	6	Annually assess recovery program and modify program and plan where required.	Ongoing	R4/ES	NCDPR, NCWRC	0.5	0.5	0.5	

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